

WHAT IS CLAIMED IS:

1 1. A method for forming a capacitor, comprising:
2 (a) forming a lower electrode on a semiconductor substrate;
3 (b) subjecting said substrate to an Atomic Layer Deposition
4 (ALD) processing using a metal-containing organic compound
5 containing one metal and an oxidizing agent to deposit a first
6 metal oxide film on said lower electrode;
7 (c) subjecting said substrate to heat treatment to be
8 performed in an oxidizing ambient in order to remove residual
9 carbon being retained in said first metal oxide film, resulting
10 in formation of a first insulating film;
11 (d) subjecting said substrate to an ALD processing using
12 a metal-containing compound containing an alternative metal
13 different from said one metal and an oxidizing agent to deposit
14 a second metal oxide film on said first insulating film, resulting
15 in formation of a second insulating film; and
16 (e) forming an upper electrode on said second insulating
17 film in order to form a capacitor including said lower electrode,
18 first insulating film, second insulating film and upper
19 electrode.

1 2. The method for forming a capacitor according to claim
2 1, further comprising between the steps (d) and (e):
3 (f) subjecting said substrate to an ALD processing using
4 a metal-containing organic compound containing and an oxidizing
5 agent to deposit a third metal oxide film on said second insulating
6 film;

7 (g) subjecting said substrate to heat treatment to be
8 performed in an oxidizing ambient in order to remove residual
9 carbon being retained in said third metal oxide film, resulting
10 in formation of a third insulating film.

1 3. The method for forming a capacitor according to claim
2 2, wherein said metal-containing organic compound employed in
3 the step (f) contains said one metal.

1 4. The method for forming a capacitor according to claim
2 2, wherein said metal-containing organic compound employed in
3 the step (f) contains a metal different from said one metal.

1 5. The method for forming a capacitor according to claim
2 1, wherein said one metal contains at least one of Zr and Hf.

1 6. The method for forming a capacitor according to claim
2 4, wherein said metal different from said one metal is titanium
3 (Ti).

1 7. The method for forming a capacitor according to claim
2 1, wherein said oxidizing ambient and said oxidizing agent each
3 contain ozone (O.sub.3).

1 8. A method for forming a capacitor, comprising:
2 (a) forming a lower electrode on a semiconductor substrate;
3 (b) subjecting said substrate to an ALD processing using
4 a metal-containing compound containing one metal and an oxidizing

5 agent to deposit a first metal oxide film on said lower electrode,
6 resulting in formation of a first insulating film;

7 (c) subjecting said substrate to an ALD processing using
8 a metal-containing organic compound containing a metal different
9 from said one metal and an oxidizing agent to deposit a second
10 metal oxide film on said first insulating film;

11 (d) subjecting said substrate to heat treatment to be
12 performed in an oxidizing ambient in order to remove residual
13 carbon being retained in said second metal oxide film, resulting
14 in formation of a second insulating film;

15 (e) forming an upper electrode on said second insulating
16 film in order to form a capacitor including said lower electrode,
17 first insulating film, second insulating film and upper
18 electrode.

1 9. The method for forming a capacitor according to claim
2 8, wherein said one metal is titanium (Ti).

1 10. The method for forming a capacitor according to claim
2 9, wherein said metal different from said one metal contains
3 at least one of Zr and Hf.

1 11. The method for forming a capacitor according to claim
2 8, wherein said oxidizing ambient and said oxidizing agent each
3 contain ozone (O.sub.3).

1 12. A method for forming a capacitor, comprising:

2 (a) forming a lower electrode on a semiconductor substrate;

3 (b) subjecting said substrate to an ALD processing using
4 a metal-containing organic compound containing one metal and
5 an oxidizing agent to deposit a first metal oxide film on said
6 lower electrode;

7 (c) subjecting said substrate to an ALD processing using
8 a metal-containing organic compound containing a metal different
9 from said one metal and an oxidizing agent to deposit a second
10 metal oxide film on said first metal oxide film;

11 (d) subjecting said substrate to heat treatment to be
12 performed in an oxidizing ambient in order to remove residual
13 carbon being retained in said metal oxide films, resulting in
14 formation of a capacitor film consisting essentially of said
15 metal oxide films; and

16 (e) forming an upper electrode on said capacitor film in
17 order to form a capacitor including said lower electrode,
18 capacitor film and upper electrode.

1 13. The method for forming a capacitor according to claim
2 12, further comprising between the steps (c) and (d):

3 (f) subjecting said substrate to an ALD processing using
4 a metal-containing organic compound containing said one metal
5 and an oxidizing agent to deposit a third metal oxide film on
6 said second metal oxide film.

1 14. The method for forming a capacitor according to claim
2 12, wherein said one metal contains at least one of Zr and Hf.

1 15. The method for forming a capacitor according to claim

2 14, wherein said metal differing from said one metal and employed
3 in the step (c) is titanium (Ti).

1 16. The method for forming a capacitor according to claim
2 12, wherein said oxidizing ambient and said oxidizing agent each
3 contain ozone (O.sub.3).